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# Marbled Murrelet Nesting Habitat Monitoring Program for Northwest Forest Plan Effectiveness Monitoring - DRAFT -

Compiled by the Northwest Forest Plan Marbled Murrelet Effectiveness Monitoring Nesting Habitat Team

## INTRODUCTION

The Marbled Murrelet Effectiveness Monitoring Plan (Madsen et al., 1999) for the Northwest Forest Plan includes determining the amount and distribution of nesting habitat on federal lands currently, and over time. The overall strategy for monitoring the Forest Plan (Mulder et al., 1999) is to develop habitat maps using vegetation classifications derived from satellite images as a cost effective tool. These maps will be updated periodically to assess changes in habitat that may reflect the effects of federal land management policies in mature and old-growth forests.

This document represents the nesting habitat team’s approach to this goal. In general the team, comprised of biologists, statisticians, and computer specialists, has agreed to develop four statistical models; two of which will result in maps and two of which will result in more mathematically accurate estimates of the amount of habitat and be applicable on a more site specific scale. Table 1. provides an overview and comparison of the different models.

## OBJECTIVES

1. Develop and test for accuracy four models of murrelet forest nesting habitat on federal lands in Washington, Oregon and northern California.

2. Use two of the models and satellite-derived vegetation classifications to map potential nesting habitat in the three states, with a selected probability of murrelet occupancy.

3. Use two of the models to develop more accurate estimates of the amount of habitat and to assess habitat at a more site specific scale.

4. Conduct bird surveys in the mapped habitat to validate murrelet occupancy.

5. Repeat the process periodically when new vegetation classifications are developed to gain a relative comparison of habitat changes over time.

## METHODS - MAP MODELS

### Murrelet Forest Surveys

Station surveys should meet the criteria of the Pacific Seabird Group's Marbled Murrelet Forest Survey Protocol. Because we wish to determine habitat associations for nesting murrelets, the response variable for analyses will be 'occupancy' (PSG, 1994), or observations of 'occupied behaviors' thought to be indicative of nearby nest locations (Singer et al., 1995). According to the Protocol, to determine if a 'site' (patch or stand of forest of up to 120 acres) is 'occupied' by murrelets, the site should be surveyed four times within a portion of the breeding season, mid-April through early August, for two consecutive years. Therefore, we will include data from sites beginning with the year 1994 and later (1995, 1996, etc.) as long as it meets the requirements of having eight station visits during two years with a minimum of three visits in one year.

Survey stations will be assigned a status of 'occupied' if any survey included observations of occupied detections. A site's status is 'occupied,' if any survey station within the site is found to be occupied. If murrelets were not detected, the station's status will be 'unoccupied' or an ‘absence’ site. Presence detections will not be used due to the concern about whether a presence detection can be tied to a particular site on the landscape. Station locations will be digitized into a GIS coverage and assigned the appropriate status.

<u>Vegetation Databases</u>

Vegetation classifications for Washington and Oregon will be produced by the Northwest Forest Plan monitoring effort (Interagency Vegetation Mapping Project) and are being done one physiographic province at a time (Figure 1). The time lines for completion of areas within the range of murrelets are as follows:

Oregon Coast Range - end of July 2000
Western Oregon Cascades - mid August 2000
Olympic - end of August 2000
Western Washington Cascades - October 2000?
Western Washington Lowlands - December 2000?
Klamath Mountains - 2001?

Maps for California have been produced by the U.S. Forest Service Region 5 remote-sensing laboratory using the Wildlife Habitat Relationships. However, these maps have yet to be accuracy assessed.

<u>Spatial and Temporal Scale</u>

The vegetation GIS coverages and the survey station point and site coverages will be combined and circular analyses plots centered on occupied stations delineated. Although the area surveyed by a station is approximately 12.5 ha, and a site surveys an area not larger than 50 ha, the surrounding landscape likely affects murrelet behaviors at the stations. The team has not selected plot sizes but is considering 400m, 800 m and 1600 m radii. *(How does this jibe with the table where we say 120 acres and 400m radii? Should I change the table to reflect this?)* A subset of the plots will be selected to minimize overlap.

Murrelet survey data used for the modeling must correspond to the time period when the satellite images were recorded, or be in sites that have not been altered within the selected spatial scale. For instance, if an 800 m radius plot size is selected for analysis, the vegetation within the plot should be unaltered since the date the images were recorded.

<u>Logistic Regression Model Development</u>

The first steps include identifying the dependent and independent variables. For the independent variables, we will make a complete list of candidate variables (see Table 1 for initial ideas). It is important to know whether variables are continuous or categorical. For categorical variables, we will identify the number of levels. The team will begin to reduce the list of independent variables based on our current knowledge of the biology of murrelets. We will agree on a process for this reduction and the number of candidate variables we should retain.

Next we will determine the candidate models. The team will agree on the maximum number of parameters we will consider fitting to the available data. Further we will agree about how to deal with interaction terms, on the first order only and all possible first order interactions. We will determine if interaction terms depend on whether variables are continuous or categorical. By doing this we will identify a set of candidate models. It may be most appropriate to use a model that includes all possible combinations of the independent variables up to the maximum number of parameters the team specified. Or we may chose a more limited subset of models. We will agree whether any variables should be guaranteed inclusion in the model. *(Realistically, how do you guys envision this working? Will we do all this for each of the areas separately or as one big group?)*

The team will decide on what statistics or other diagnostics to use that will best help us fit candidate models and compare fits. The group has agreed to use Akaike's Information Criterion (AIC), a tool used for model selection. This will help us select the final model or models. We will agree how this final selection process will be done. Finally, we will assess model quality by using cross validation techniques to get improved estimates of prediction error.

<u>Habitat Mapping</u>

Once a model is selected the team will apply it to the vegetation databases and map potential habitat. To validate the model, murrelet forest surveys will be conducted following an appropriate sampling design. *(This is a crucial step since most of the occupancy and absence sites we will have to work with were driven by timber harvest locations. So far the program managers have not provided funding for this step. We need to develop a sampling design we can agree to and start pushing this very hard.)*

METHODS - NON-MAP MODELS

<u>Murrelet Forest Surveys</u>

See text on map models.

<u>Site Plot Databases</u>

Plot data is available from a variety of murrelet studies and from stand exams conducted for forest inventory and harvesting activities. This will provide data about murrelet habitat and general forest conditions.

Previous murrelet studies of a similar nature should provide a good starting point for selecting independent variables. These studies compared areas used by murrelets with all potentially available habitat or with specific sites determined to be unoccupied (appropriate citations). Research on nest sites will also contribute important habitat characteristics about nests, their immediate surroundings and the broader scales of plots or stands (appropriate citations).

In addition, the Forest Service and Bureau of Land Management have participated in gathering vegetation information at plots on a large-scale systematic basis across both federal and nonfederal lands. Generally, the Current Vegetation Surveys (CVS) occur on federal lands and the Forest Inventory Analysis (FIA) plots occur on nonfederal lands across the species' range (appropriate citations?). Both groups have begun to collect data on two murrelet habitat variables within the species' range, percent moss and platform abundance. These data sources should provide good estimates of the amount of nesting habitat because they are derived from systematic random samples in a grid pattern across the landscape.

## Spatial Scale

This information will be derived from studies and plots of different scales, for example a FIA plot is less than one hectare, a murrelet station covers about 12.5 ha, while an occupancy site can be 50 ha. However, the independent variables will be put on a per unit basis.

## Logistic Regression Model Development

See text on map models.

## Habitat Models

These models will also need validation through additional surveys and vegetation plot information. This information will be obtained as much as possible in conjunction with the data gathered for the map model validation.

Table 1. Murrelet Nesting Habitat Models

| | Map Model | | Non-Map Model | |
|---|---|---|---|---|
| Definition | Use vs. Avail. | Use vs. Non-use | Use vs. Avail. | Use vs. Non-use |
| Dependent Variables | Occupied analyzed separate from known nest sites<br><br>OR<br><br>Model built with occupancy and reserve nest sites for a partial validation | Occupied vs absence (only those done to protocol). | Occupied analyzed separate from known nest sites<br><br>OR<br><br>Model built with occupancy and reserve nest sites for a partial validation | Occupied vs absence<br><br>Nest vs Non-nest |
| Basic Model Form | Logistic regression for occupancy and nest sites | | | |
| Clear expectations of what is possible for models | Produce a 'probability of occupancy' map with a clear understanding of precision/level of confidence. (E.g., an area has a low, medium or high probability of occupancy with a 90% confidence interval ± 5% ).<br><br>*Deferred some of this discussion. | | Predict the best 'probability of occupancy' on a site level (knowing something about a particular site)<br><br>Examine other models for the biological meaning of parameters and potentially find surrogate measurements that are cheaper, or more readily available. | Predict the best 'probability of occupancy' on a site level (knowing something about a particular site) |
| Potential Uses of the Model | Graphic depiction of habitat distribution, abundance, and degree of fragmentation with known level of precision at any given point on the map. | | Estimate habitat quantities.<br><br>Tracking changes in | Estimate habitat quantities. |

| | Map Model | | Non-Map Model | |
|---|---|---|---|---|
| Definition | Use vs. Avail. | Use vs. Non-use | Use vs. Avail. | Use vs. Non-use |
| | Compare relative changes in habitat configuration over time. | | habitat amounts over time.<br><br>Determine likelihood of murrelet occupancy (maybe a useful tool at a watershed scale planning effort).<br><br>May obviate the need for surveys at a site.<br><br>(Model evaluation will reflect on the appropriateness of the models for these uses.) | |
| Independent Variables | Quadratic mean diameter for the dominates and co-dominants<br><br>% Cover (conifer canopy)<br><br>Topographic variables such as slope, aspect, elevation, distance to ocean, distance to fresh water<br><br>Site size (as determined by number of stations assumed to be 30 acres unless you know the actual)<br><br>Structure (simple vs. complex)<br><br>*Deferred discussion on distance to nearest similar habitat (how do you characterize "similar" and how do you decide the nearest distance"…) | | Start with Kim/Tom's plot data:<br>tree density<br>mean tree diameter<br>platform density<br>moss abundance<br>tree height<br>(dominant, mid and low canopy)<br>canopy cover<br>slope<br>aspect<br>elevation<br>distance to coast<br>distance to stream<br>distance to openings<br>mistletoe<br>CVS/FIA/BLM | |

| | Map Model | | Non-Map Model | |
|---|---|---|---|---|
| Definition | Use vs. Avail. | Use vs. Non-use | Use vs. Avail. | Use vs. Non-use |
| | | | NEST VARIABLES:<br>mean platform diameter<br>horizontal cover, etc.<br><br>(stand exam data might help describe characteristics at use and non-use sites) | |
| Issues of scale | Same scale as protocol (a site = up to 120 acres)<br><br>A. 400m radius circle centered at the center (geometric mean) of the stations<br><br>OR<br><br>B. 400m radius circle centered at the center of the site (need to get a cost estimate for this)<br><br>Need to determine how this will be made consistent, objective, and well-defined. | | Scale of a given site. Independent variables put on a per unit basis | |
| Combining scale and independent variables | About 800 pixels per site.<br><br>Quadratic mean diameter for the dominates and co-dominants: (e.g., mean % of pixels ≥ some undetermined value [50cm or 70cm], or clusters sizes of 1, 5, or 10 pixels with ≥ 50cm [or 70cm])<br><br>% Cover (conifer canopy)<br>(e.g., mean % of pixels ≥ some undetermined value [10%, 50%, or 80%])<br><br>Topographic variables such as slope, aspect, elevation, distance to ocean, distance to fresh water | | N/A | |

| | Map Model | | Non-Map Model | |
|---|---|---|---|---|
| Definition | Use vs. Avail. | Use vs. Non-use | Use vs. Avail. | Use vs. Non-use |
| | (e.g., mean % of pixels with slope some undetermined value [5% or 10%])<br><br>Structure (simple vs. complex)<br><br>* Deferred Fragstat statistics: patch size, spatial patterns, distance to nearest similar habitat, etc. | | | |
| Reference Population | Temporal: Using 1994 to present (as long as it met our required two year survey, eight visits, three visits in one year).<br><br>Also date of stand exam data.<br><br>Spatial: Split WA & OR from CA due to the different approaches used in FS R5 and FS R6 to develop vegetation classification systems from satellite images. | | | |
| Variable Selection | All Possible Subsets using Akaike's Information Criterion (AIC) with a screening process built-in. | | | |
| Model Evaluation | A statistical/mathematical evaluation done without ground data (no new information). First answer: what is the model supposed to do? How well does it need to perform that function? | | | |
| Further Model Development | Will likely need to go back and fill information gaps. This also could occur during the model development stage. | | | |
| Model Validation | Obtain more data or save some portion of the data set (nest sites) to help validate. May need to get both habitat and bird-use. Surveys may be the best method since it gives info about the bird use (occupancy). Problem is that some sites may not show birds because of biological reasons. Need to have a large enough sample size to capture combinations of the independent variables that are important. | | Additional data will very likely be necessary. | |

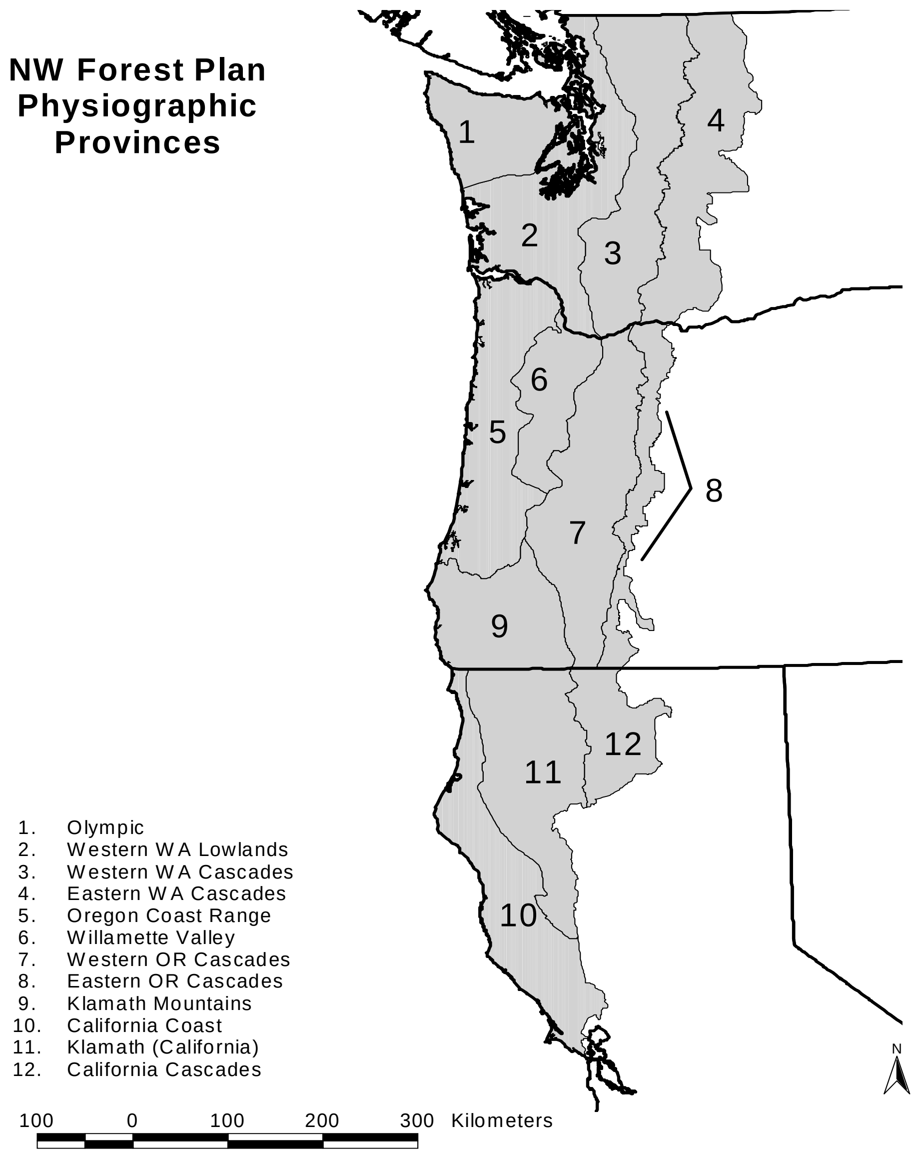


Figure 1. Forest Plan Physiographic Provinces

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